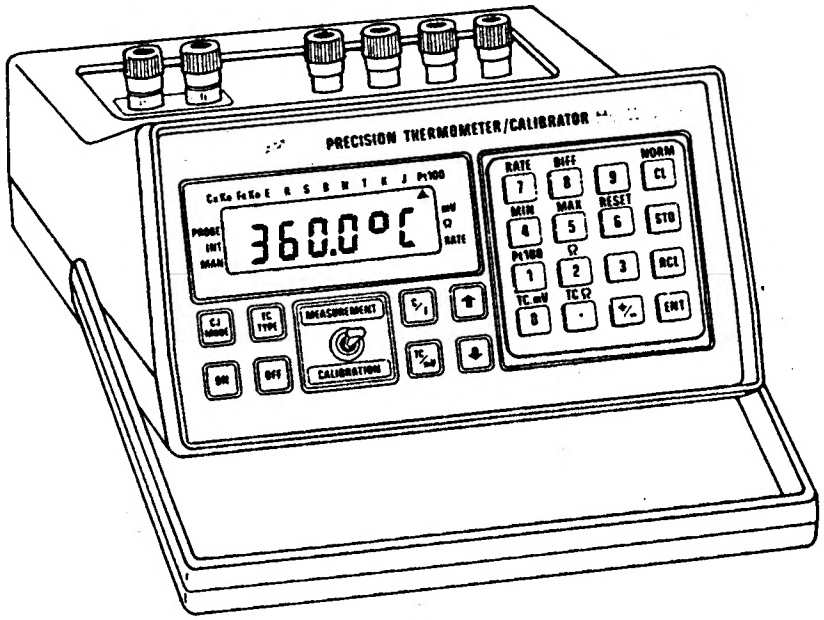
CL521

Temperature Calibrator/Thermometer



OMEGA®

An OMEGA Technologies Company

Operator's Manual

M1269/0491

WARRANTY

OMEGA warrants this unit to be free of defects in materials and workmanship and to give satisfactory service for a period of 25 months from date of purchase. OMEGA Warranty adds an additional one (1) month grace period to the normal two (2) year product warranty to cover handling and shipping time. This ensures that our customers receive maximum coverage on each product. If the unit should malfunction, it must be returned to the factory for evaluation. Our Customer Service Department will issue an Authorized Return (AR) number immediately upon phone or written request. Upon examination by OMEGA, if the unit is found to be defective it will be repaired or replaced at no charge. However, this WARRANTY is VOID if the unit shows evidence of having been tampered with or shows evidence of being damaged as a result of excessive corrosion; or current, heat, moisture or vibration; improper specification; misapplication; misuse or other operating conditions outside of OMEGA's control. Components which wear or which are damaged by misuse are not warranted. These include contact points, fuses, and triacs.

There are no warranties except as stated herein. There are no other warranties, expressed or implied, including but not limited to the implied warranties of merchantability and of fitness for a particular purpose. OMEGA ENGINEERING, INC. is not responsible for any damages or losses caused to other equipment, whether direct, indirect, incidental, special or consequential, which the purchaser may experience as a result of the installation or use of the product. The buyer's sole remedy for any breach of this agreement by OMEGA ENGINEERING, INC. or any breach of any Warranty by OMEGA ENGINEERING, INC. shall not exceed the purchase price paid by the purchaser to OMEGA ENGINEERING, INC. for the unit or units or equipment directly affected by such breach.

Every precaution for accuracy has been taken in the preparation of this manual, however, OMEGA ENGINEERING, INC. neither assumes responsibility for any omissions or errors that may appear nor assumes liability for any damages that result from the use of the products in accordance with the information contained in the manual.

RETURN REQUESTS/INQUIRIES

Direct all warranty and repair requests/inquiries to the OMEGA ENGINEERING Customer Service Department: call Toll Free 1-800-622-2378, FAX 203-359-7811; International: 203-359-1660, FAX: 203-359-7807.

BEFORE RETURNING ANY PRODUCT(S) TO OMEGA, YOU MUST OBTAIN AN AUTHORIZED RETURN (AR) NUMBER FROM OUR CUSTOMER SERVICE DEPARTMENT (IN ORDER TO AVOID PROCESSING DELAYS). The assigned AR number should then be marked on the outside of the return package and on any correspondence.

FOR **WARRANTY** RETURNS, please have the following information available BEFORE contacting OMEGA:

1. P.O. number under which the product was PURCHASED,
2. Model and serial number of the product under warranty, and
3. Repair instructions and/or specific problems you are having with the product.

FOR **NON-WARRANTY** REPAIRS OR **CALIBRATION**, consult OMEGA for current repair/calibration charges. Have the following information available BEFORE contacting OMEGA:

1. Your P.O. number to cover the COST of the repair/calibration,
2. Model and serial number of product,
3. Repair instructions and/or specific problems you are having with the product.

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SECTION 1 INTRODUCTION

1.1 GENERAL DESCRIPTION

The OMEGA CL521 is a precision, high-accuracy calibrator for use on the bench or in the field. Featuring exceptionally high accuracy, the CL521 can measure any of ten thermocouple types, platinum RTDs, millivolts, or ohms. The CL521 is also an instrument calibrator, allowing users to calibrate or check the above sensor type instrumentation.

The CL521 is designed for ease of use, with a large, easy-to-read LCD display with 0.41" (10.4 mm) digits. A touch-sensitive keypad makes function selection and value entry fast and easy, while a toggle switch simplifies selection between measurement and calibration functions. The CL521 can store up to six values for quick selection of common calibration temperatures, as well as store six measurement readings. Other features include rate of change calculation, min and max storage, and differential measurement from a stored value.

The CL521D has all the features of the CL521 with the addition of RS-232C two-way communications and an analog output. The RS-232C communications can be used for remote computer control of the unit, as well as for transmitting data to a computer, printer or datalogger. The analog output is a 1 mV per degree signal, with 10x amplification when using the differential function of the CL521D.

Each unit is supplied complete with carrying case, connector leads, type K thermocouple extension cable with male connector, calibration certificate, TAS-U-5 connector, and AC power adapter.

1.2 FEATURES

- Calibrate and Measure J, K, T, E, R, S, B and N Thermocouples
- Measure 100 ohm Pt RTDs
- Math Functions Calculate Rate of Change and Difference
- Min/Max Storage
- Store up to Six Simulations for Quick Recall
- Enter Calibration Values Directly from Keypad or Through Up/Down Increment Keys
- Available with Optional RS-232C and Analog Output

1.3 AVAILABLE MODELS

MODEL NUMBER	DESCRIPTION
CL521	Temperature calibrator/indicator
CL521D	Calibrator with RS-232C and analog output
CL521-RS232C	RS-232 interface board (includes software)
CL521-MA	Milliamp board with 24 Vdc supply

SECTION 2 INSTALLATION

2.1 UNPACKING

Remove the packing list and verify that all equipment has been received. If there are any questions about the shipment, please call the OMEGA Customer Service Department at 1-800-622-2378.

Upon receipt of shipment, inspect the container and equipment for any signs of damage. Take particular note of any evidence of rough handling in transit. Immediately report any damage to the shipping agent.

NOTE

The carrier will not honor any claims unless all shipping material is saved for their examination. After examining and removing contents, save packing material and carton in the event reshipment is necessary.

All units are supplied with carrying case, connector leads, type K thermocouple extension cable with male connector, calibration certificate, TAS-U-5 connector, and AC power adapter.

2.2 REMOVING THE CARRYING CASE

In laboratories and maintenance shops, the CL521 is easiest to use without its carrying case. In order to remove the carrying case, be sure the AC adaptor is not connected, then open both carrying case flaps and the strap around the instrument. Lift the rear of the instrument about an inch, lift the front of the instrument, and pull it out of the case. The unit's carrying handle may then be turned downwards in front to act as a stand for easier viewing. The unit is installed into its case in the reverse order.

In the field, the carrying case is most convenient. When carried around the neck, the unit can easily be used merely by opening the flap in front of the panel and turning it over to the back of the case.

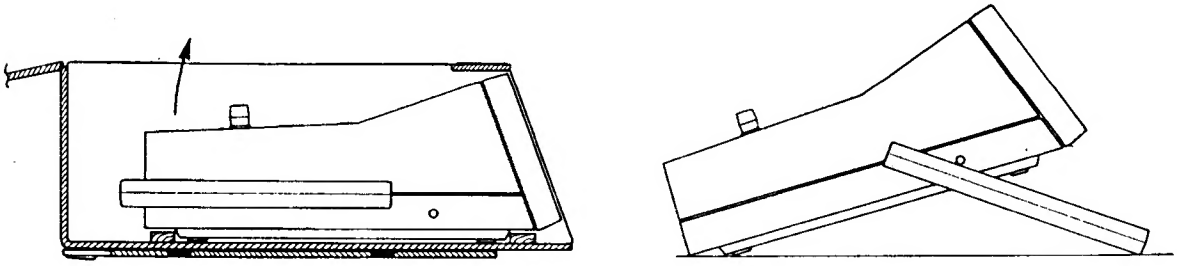


Figure 2-1. Removing the Carrying Case

2.3 CHARGING THE BATTERY

The power used by the unit comes from the internal battery, which also keeps certain program parameters in memory even when the unit is switched off. The unit comes with its battery partially charged and it is therefore advisable to charge the battery before use.

When the rechargeable batteries in the instrument begin to run down, the message "BATTLO" appears periodically on the display. If the battery voltage goes too low, the instrument switches itself off to prevent destructive discharge of the batteries and loss of data stored in the memory registers.

When "BATTLO" appears on the display, the battery should be recharged as soon as possible. Plug the charger cable into the connector at the rear of the unit. Connect the charger to the 120 VAC, making sure that the line voltage is correct. Charge the battery for approximately 12 hours; 20 hours if used during charging.

2.4 WIRING CONNECTIONS

The CL521 connection terminals are found on top of the unit. Connections are easily made and wires are kept out of the way of the display and keypad. When using the CL521 in its carrying case, the flap in front of the connection panel may be shut during use. This reduces changes in reference temperature of thermocouple temperature measurements, thus ensuring measurement accuracy in environments where ambient temperature may vary greatly.

The terminal panel contains two separate types of connections.

The TC and mV connection is used for thermocouple and millivolt measurement and simulation/calibration. When the MEASUREMENT/CALIBRATION switch is in the MEASUREMENT position, this connection measures inputs. The CALIBRATION position provides a calibration output signal. The resistance of a circuit connected to the TC and mV connection may also be measured by using the TCΩ measurement function.

The Ohm and Pt100 connection is used to measure the resistance of Pt100 or other resistive probes. Both three and four-wire connections are possible.

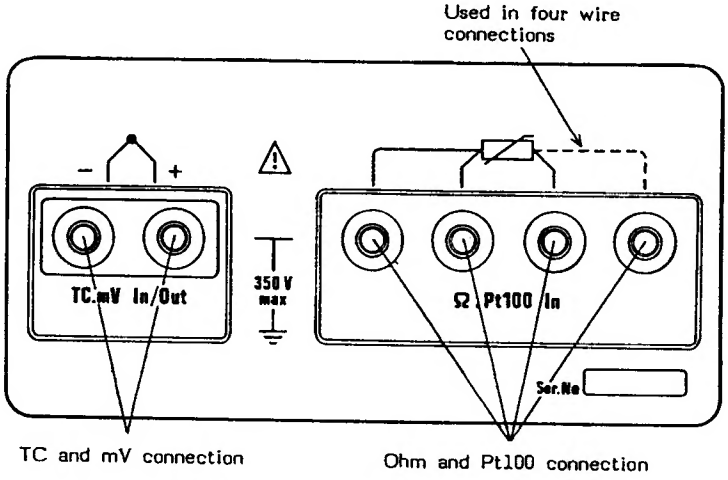


Figure 2-2. Terminal Panel

SECTION 3 GENERAL OPERATION

3.1 FRONT PANEL FUNCTIONS

The functions of the CL521 have been chosen for their usefulness in temperature measurement and calibration. The functions are easily selected from the keypad on the front panel. CL521 functions are listed below and shown in Figure 3-1. For more complete instructions, refer to Sections 4 to 7.

THERMOCOUPLE MEASUREMENTS:

- Temperature measurement in either °C or °F using ten different thermocouple types

  Reference junction modes:

  - External reference junction, if the temperature value is not 0°C, must be entered into the memory.
  - Reference temperature is measured using a Pt100 α = 0.00385 resistance probe
  - Reference temperature is measured using an internal sensor
- Millivolt measurement -10 to 110 mV
- Thermocouple resistance measurement

RESISTANCE MEASUREMENT:

- Temperature measurement in °C or °F using a Pt100 α = 0.00385 resistance probe
- Ohm measurement 0 to 400 ohms

ADDITIONAL MEASUREMENT FUNCTIONS:

- Rate of change measurement
- Measurement of deviation from a preset value
- Storage of minimum and maximum values

CALIBRATION FUNCTIONS:

- Thermocouple simulation in °C or °F
- Millivolt calibration -10 to 110 mV

  Entry of calibration values:

  - From keypad
  - From memory
  - Smooth increase or decrease
  - Fine adjust using INC and DEC switches
  - Automatic stepping through five preset calibration values

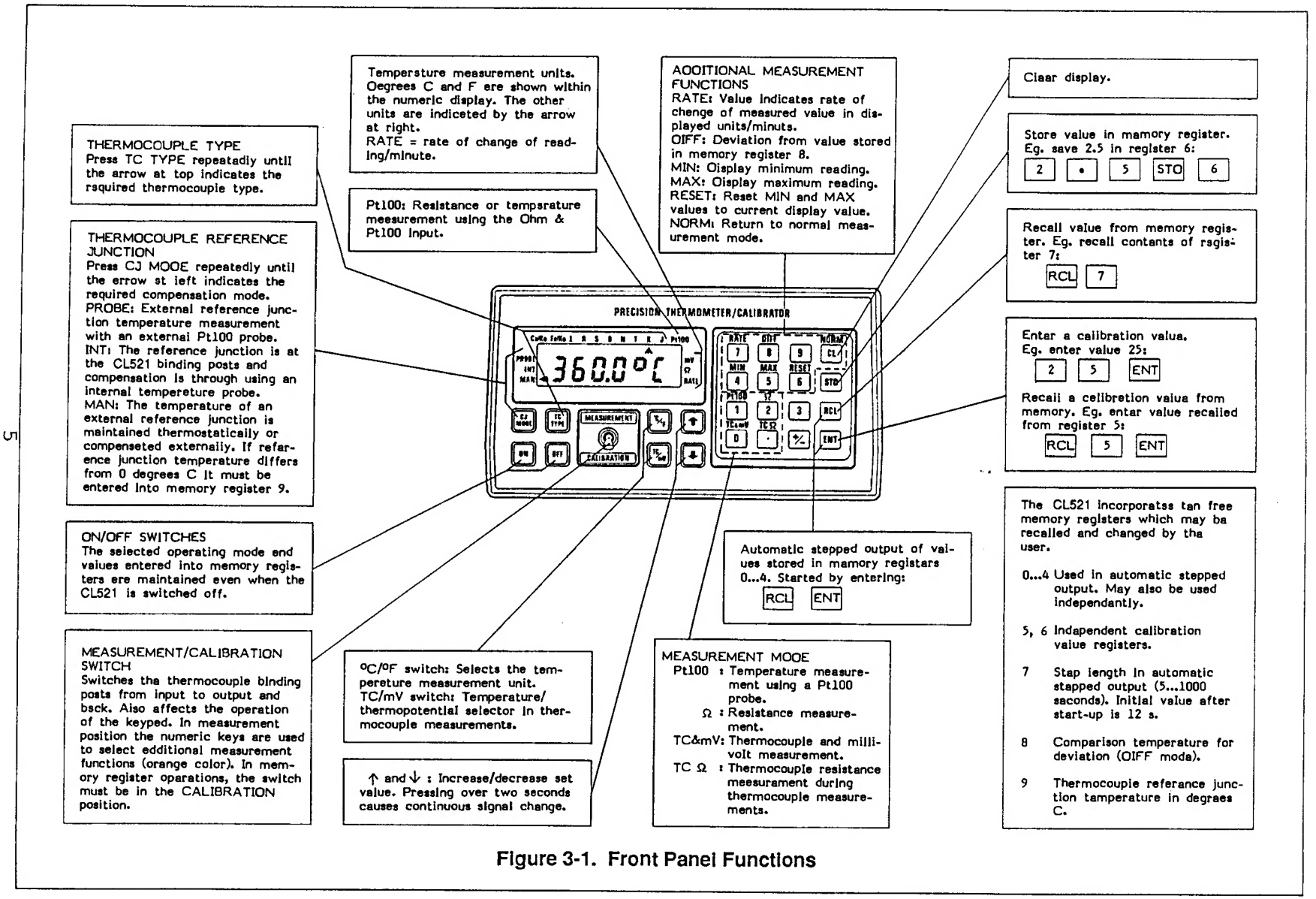


Figure 3-1. Front Panel Functions

3.2 INITIAL START-UP

The CL521 is switched on and off by pressing the ON and OFF keys, respectively. After the instrument is switched on, it performs various routines and self-tests. A message flashes on the display indicating the version of the CL521. After this, the unit begins operation in the most recently used mode of operation.

SECTION 4 THERMOCOUPLE AND MILLIVOLT MEASUREMENTS

4.1 THEORY OF OPERATION

A thermocouple is a temperature probe composed of two wires of different materials connected together. There is a specific thermopotential between the wires which varies non-linearly as a function of temperature.

If two wires of different materials A and B are connected in a loop as shown, the thermoelectric effect causes a flow of current through the loop, corresponding to the temperatures T1 and T2 at the junction points.

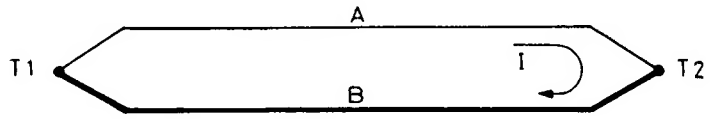


Figure 4-1. Basic Thermocouple Circuit

If the circuit is broken, its thermopotential can be measured. Assuming the voltmeter does not create a load in the circuit, the potential is determined solely by temperatures T1 and T2 (the thermopotentials of the copper wires and the thermocouple conductors cancel each other as long as both connections are at the same temperature).

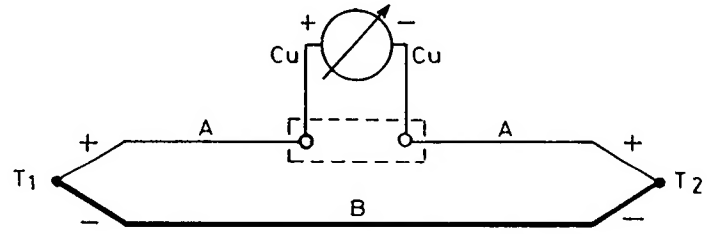


Figure 4-2. Thermocouple Circuit with Meter

Normally T1 is measured while the reference junction temperature is kept at a constant temperature T2, or is somehow compensated for during evaluation of the measured value.

Frequently, the circuit is broken at the reference junction. Thus the reference junction is moved to the point where the connection is made from the thermocouple conductors to the copper wires.

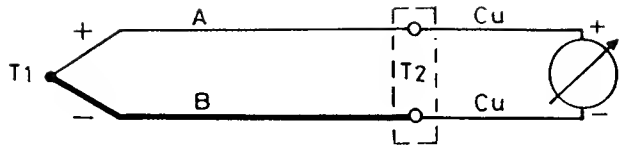


Figure 4-3. Thermocouple with Reference Junction and Voltmeter

4.2 REFERENCE JUNCTION TEMPERATURE

The reference junction temperature is easiest to compensate for by measuring the temperature of closely situated reference junctions using, for example, a resistance temperature probe.

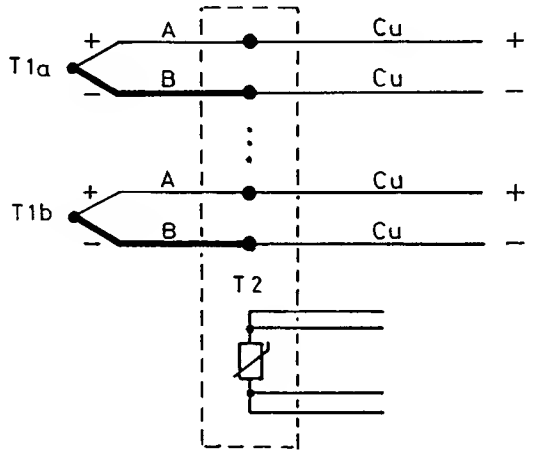


Figure 4-4. Reference Junction Compensation Using a Pt100 Probe

The temperature of the reference junctions can also be kept constant by cooling or heating them with the aid of a thermostat. When cooling, 0°C is most convenient. When heating, a temperature is selected which is somewhat hotter than room temperature, for example, 50°C.

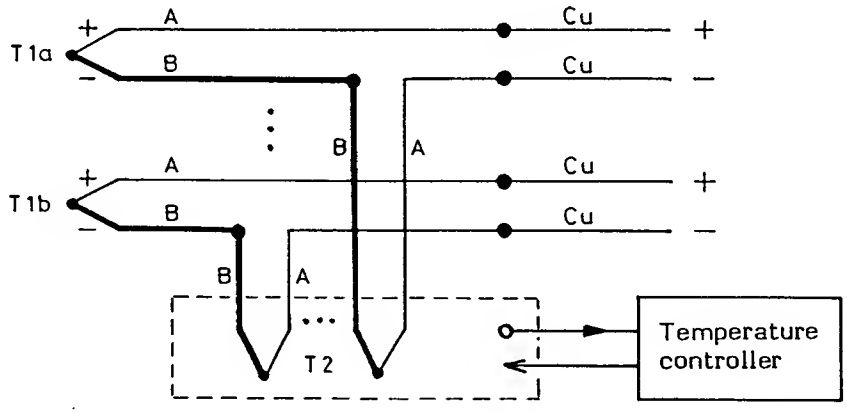


Figure 4-5. Reference Junction Compensation Using a Temperature Controller

The reference junction can also be placed into a "compensation circuit." A temperature sensor measures the reference junction temperature, and feeds a correction potential into the measurement circuit as the reference junction temperature varies. Thus the temperature of the reference junction appears constant to the measurement circuit. The compensation temperature is normally 0°C.

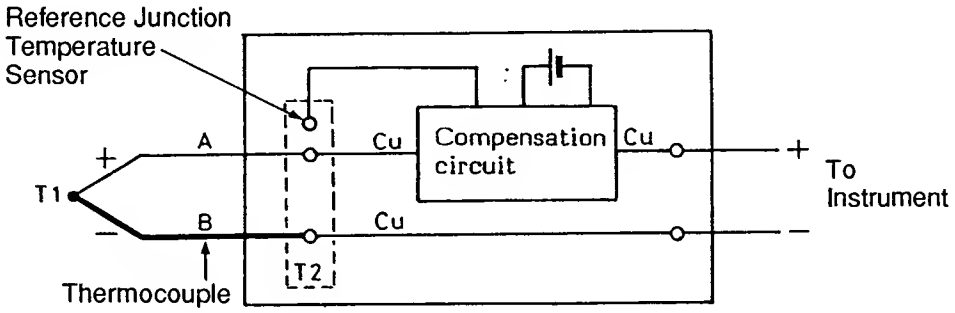


Figure 4-6. Electronic Reference Junction Compensation Circuit

4.3 THERMOCOUPLE MEASUREMENTS

4.3.1 Connections and Reference Junction Mode Selection

Connect the thermocouple wires if it has not been done already. Use the polarity marked on the terminal panel. Carefully consider whether you shall use copper leads or thermocouple extension cables. The extension cable must conform to the thermocouple both by type and polarity. If the external reference junction temperature is to be measured, also connect a Pt100 probe.

The CL521 incorporates three different reference junction modes:

A) Internal reference junction compensation, CJ MODE = INT

B) External reference junction compensation using a Pt100 probe, CJ MODE = PROBE

C) Manual reference junction compensation, CJ MODE = MAN

A) INTERNAL REFERENCE JUNCTION COMPENSATION, CJ MODE = INT

The thermocouple is connected directly, or through thermocouple extension cables to the CL521 thermocouple terminal posts. This is the most common method of compensation for reference junction temperature, but you must use the correct type of thermocouple extension cables.

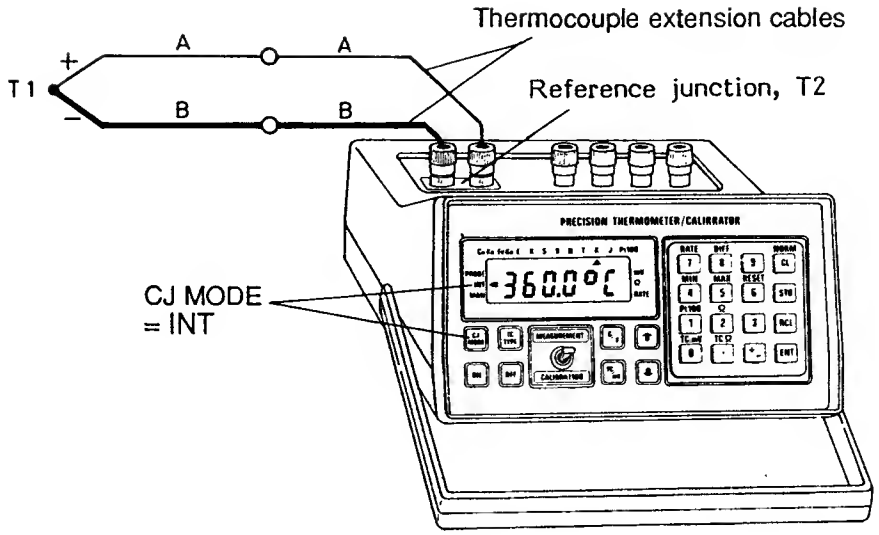


Figure 4-7. Measurements Using Thermocouple Extension Cables

In the field, the ambient temperature may change suddenly. Under such conditions, accurate reference junction compensation can be ensured by closing the flap on top of the terminal panel during use.

The instrument is shipped complete with a connecting cable for a type K thermocouple. Connect the miniature connector on the cable to the terminals according to the polarity shown.

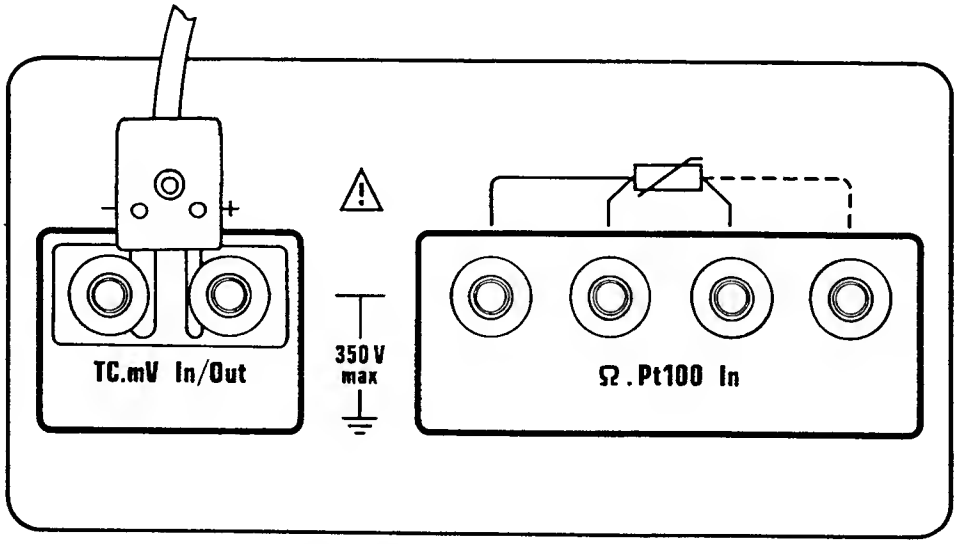


Figure 4-8. CL521 Terminal Panel

B) REFERENCE JUNCTION COMPENSATION USING A Pt100 PROBE
CJ MODE =PROBE

In this mode, the reference junction T2 is outside the CL521 at a location where a Pt100 probe is also installed. The thermocouple is connected to the CL521 with copper wires and the Pt100 probe is connected to the Pt100 terminals.

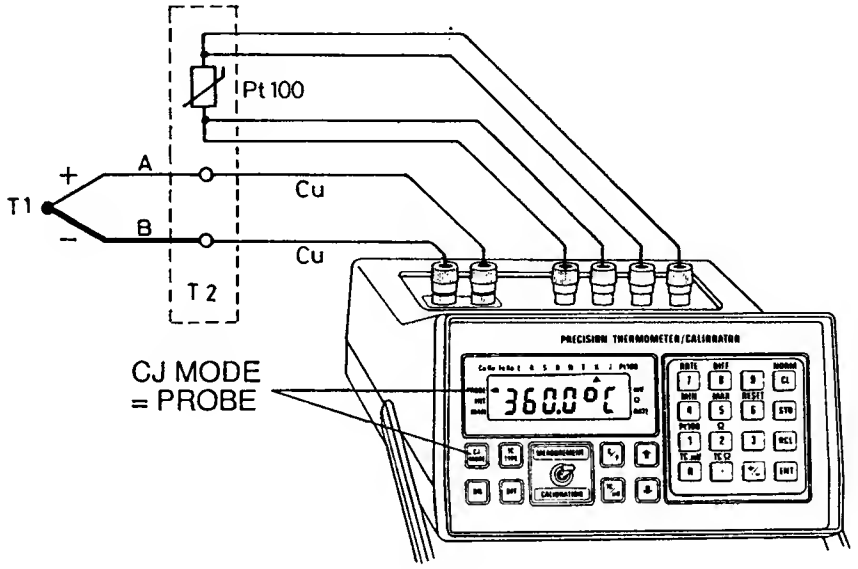


Figure 4-9. Reference Junction Compensation Using a Pt100 Probe

C) MANUAL REFERENCE JUNCTION COMPENSATION, CJ MODE = MAN

Reference junction temperature compensation is automatically set to 0°C, using the external reference junction. The thermoelectric potential is connected to the CL521 using copper leads.

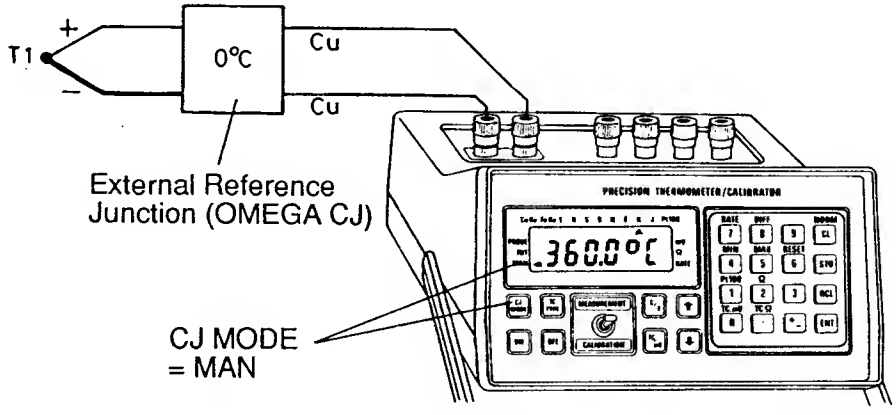


Figure 4-10. Manual Reference Junction Compensation

4.3.2 Measuring Temperature

Once connections are completed, measurements can be performed. If the CL521 was most recently used for the same type of measurements, it is ready to use once the power is switched on. Otherwise:

Check that the MEASUREMENT/CALIBRATION switch is in the MEASUREMENT position.

Choose thermocouple measurement by pressing the TC & mV key.

If the display is showing millivolts (an arrow at the right edge of the display is pointing to mV), change it to temperature display by pressing the TC/mV key once.

An arrow at the upper edge of the display will now indicate the most recently used thermocouple type. Select, if needed, the required type by pressing the TC TYPE key repeatedly.

Select the required reference junction compensation mode by pressing the CJ MODE key repeatedly until the arrow at the left edge of the display is pointing to the required mode.

The CL521 will now measure potential from a thermocouple and convert it according to the NIST Conversion Tables to a temperature reading. The temperature units (°C or °F) will be the ones most recently used. To change the temperature units, press the °C/°F key once.

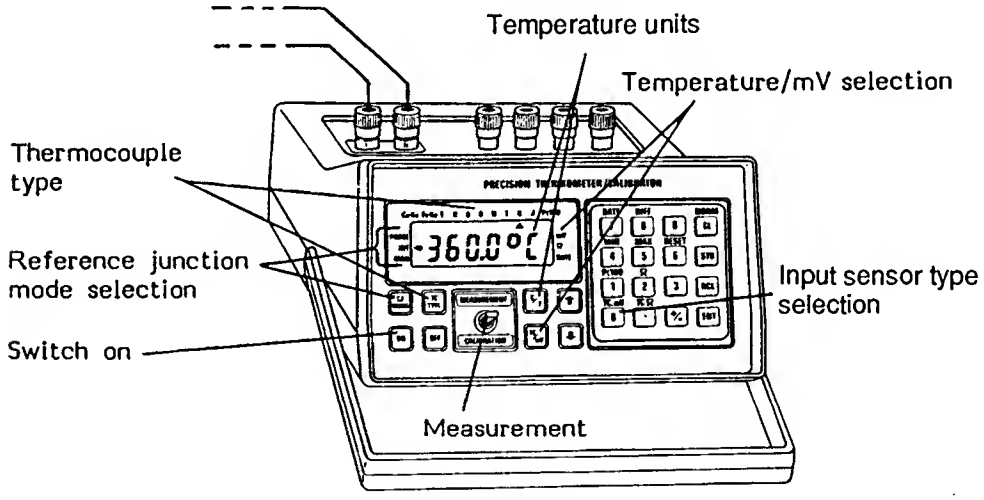


Figure 4-11. CL521 Calibrator/Thermometer

A specific temperature measurement range has been defined for each type of thermocouple. If the measured temperature is outside this range, the display flashes the corresponding minimum or maximum temperature. If the reference junction temperature goes below -10°C or above +70°C, the unit displays "CJ LO" or "CJ HI", respectively.

4.3.3 Checking and Setting Reference Junction Temperature

The temperature in the reference junction compensation circuit or the compensation temperature of an external compensation circuit may be set to a temperature other than 0°C. The external reference junction temperature may also be measured by methods other than a Pt100 probe. In all these cases, manual compensation for reference junction temperature must be used, and that temperature value stored into memory Register 9.

The value in Register 9 indicates the temperature of the reference junction in °C, regardless of the selected temperature units. Register 9 is automatically set to zero whenever the manual reference junction compensation mode is selected.

To check the reference junction temperature, or to change it, proceed as follows:

NOTE: Make sure the MAN reference junction compensation mode is selected.

Switch the MEASUREMENT/CALIBRATION switch to the CALIBRATION position.

Recall Register 9 (the reference junction temperature) to the display by entering:

RCL 9

The display will show, for example, "CJ 0.00 C".

To set the reference junction compensation temperature to 50°C, for example, enter:

5 0 STO 9

After checking and/or setting the reference junction temperature, return the MEASUREMENT/CALIBRATION switch back to the MEASUREMENT position.

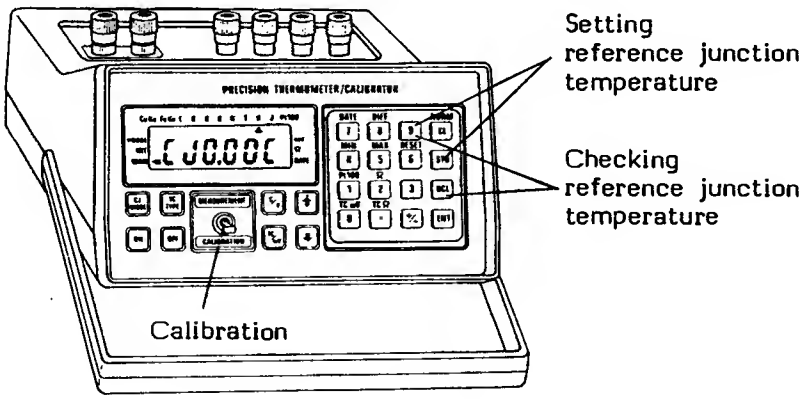


Figure 4-12. Checking and Setting Reference Junction Temperature

The reference junction temperature in Register 9 can also be checked while using the internal reference junction compensation (INT), or while measuring the reference junction temperature with a Pt100 probe (PROBE).

4.4 MEASURING THERMOCOUPLE RESISTANCE

The CL521 can be used to measure the resistance of a thermocouple circuit during thermocouple temperature measurements. The measurement will yield a correct resistance regardless of the prevailing thermoelectric potential.

Display the circuit resistance by pressing the TCΩ key while in TC & mV mode.

Return to the normal measurement mode by pressing the TC & mV key.

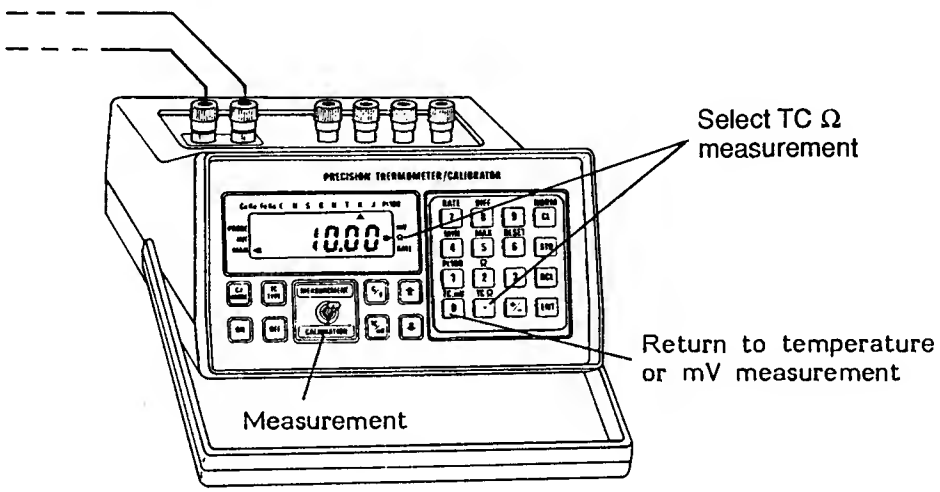


Figure 4-13. Measuring Thermocouple Resistance with the CL521

The resistance measurement range is 0 to 400 ohms. Exceeding this range causes the display to blink the maximum allowed resistance. If the measurement circuit is broken, the display will indicate "OPEN".

Thermocouple resistance measurements can be used:

- to determine the condition of the measurement connections and to help locate short circuits.

- to help in adjusting the measurement circuit resistance when meter movement indication devices are used to measure thermoelectric potential.

- to predict the expected lifespan of a thermocouple by monitoring the change in its resistance as a function of time, and comparing the measured values to data collected from previous experiences.

- for various checks when accuracy requirements do not warrant the use of three or four wire connections, for example to determine the wire order when connecting a three or four wire probe.

4.5 MEASURING MILLIVOLTS

If the instrument was most recently used for mV measurement, it will be ready to use once the power is turned on. If it was not recently used for mV measurement:

Check that the MEASUREMENT/CALIBRATION switch is in the MEASUREMENT position.

Select the mV input by pressing the TC&mV key.

Check that the measured value is shown in millivolts (an arrow at the right edge of the display will point to mV). If mV is not being shown, press the TC/mV key once.

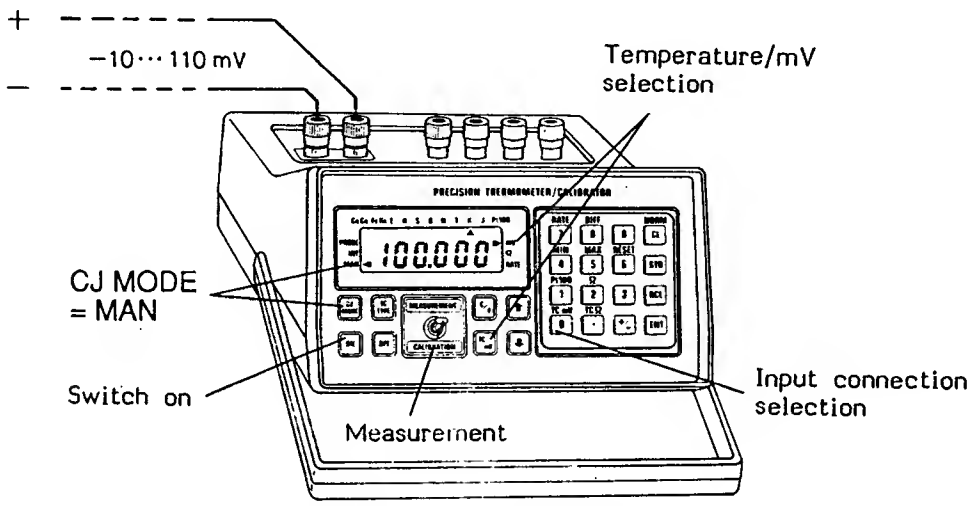


Figure 4-14. Measuring Millivolts with the CL521

The CL521 will now measure millivolts. Reference junction compensation is automatically disconnected (the CJ MODE arrow indicates MAN and Register 9 is set to 0°C).

If the potential being measured goes below -10 mV or above 110 mV, the display will blink the minimum or maximum measurement values to indicate range underflow or overflow.

SECTION 5 Pt100 RESISTANCE MEASUREMENTS

5.1 GENERAL INFORMATION

Resistance probes are often used for temperature measurement. Currently the most common probe type is the Pt100 resistance probe. It is constructed from platinum wire having a resistance of 100 ohms at 0°C. The resistance increases with temperature, because metal wires have a positive thermal coefficient of resistance.

In measuring the resistance of a probe, the effect of lead wire resistances between probe and measuring device must be compensated for. Normally, the change of the lead resistance as its temperature changes must also be considered. Accurate measurements require that the connecting cable have at least three, and preferably four, conductors.

5.2 CONNECTING A RESISTANCE PROBE

Ideally, the best method of eliminating the effect of lead resistance is to use four conductors when measuring the temperature with the probe. Two conductors are required to carry the measurement current through the resistance, while the other two are used to measure the voltage across the probe.

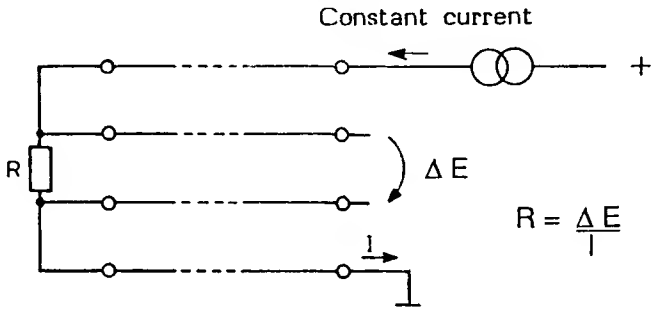


Figure 5-1. Basic Pt100 Measuring Circuit

The CL521 uses this method in resistance measurements. By measuring potentials both with and without current flow, the unit can also eliminate possible thermoelectric potentials caused by conductor connections.

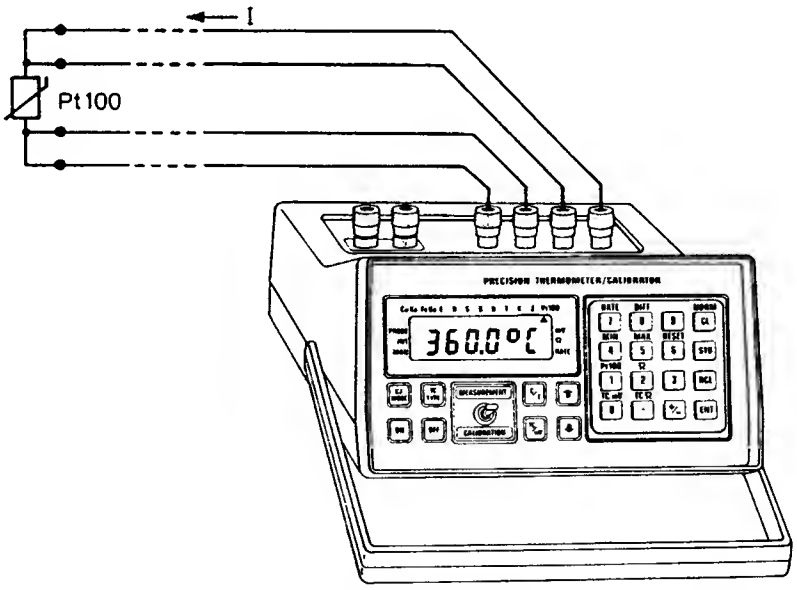


Figure 5-2. Connecting a 4-Wire Resistance Probe to the CL521

In three-wire connections, one wire is connected to one end of the resistance probe, and two wires are connected to the other end. Probe resistance can be measured using many different methods, but all of these require that at least two of the conductors in the cable are identical. Some methods even require that conductor resistances be "tuned" to specific constant values.

The voltage across the probe can also be measured with three wires. The voltage drop in the current circuit is measured and cable effects are compensated for on the assumption that the voltage drop in the feed conductor is identical to that in the return conductor.

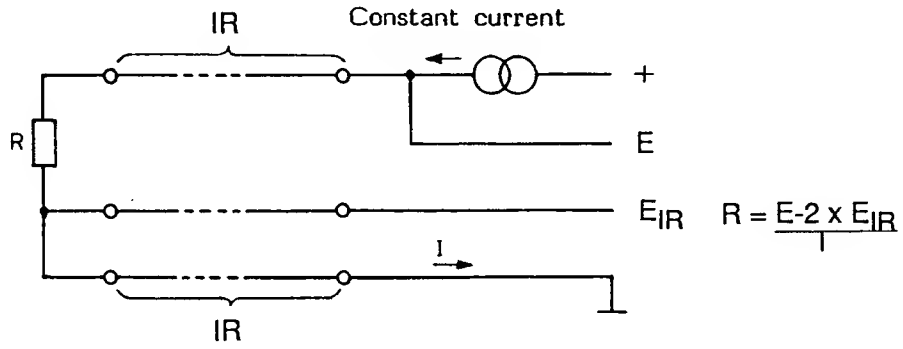


Figure 5-3. Pt100 Measuring Circuit

If the probe is connected to the CL521 using three conductors, the instrument automatically detects the lack of the fourth conductor and begins to operate in the three wire mode. The fourth conductor should, however, be used whenever possible.

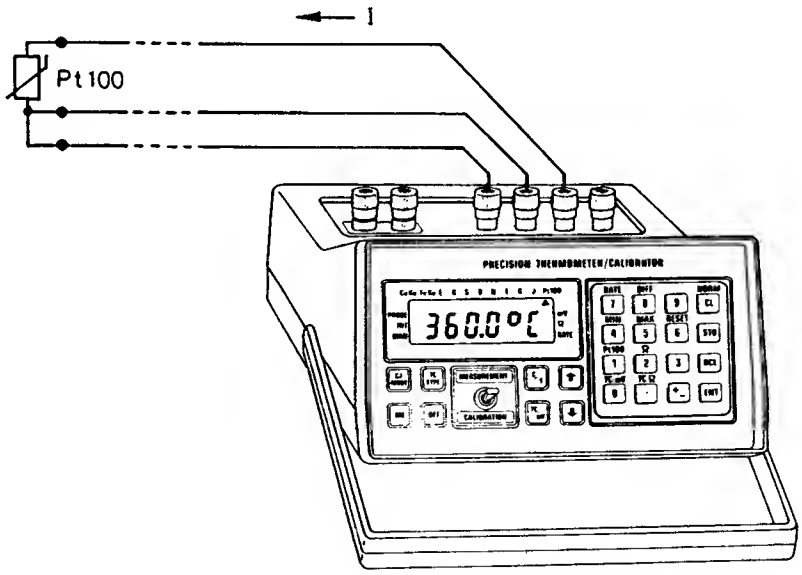


Figure 5-4. Connecting a 3-Wire Resistance Probe to the CL521

In actual bridge circuit measurements the probe is often connected using four leads, two of which are connected across the sensing probe, while the other two are shorted to form a compensation loop. If the cable leads and connections are correct, the resistance of the compensation lead loop is equal to the resistance in the measurement loop. The properties of this method resemble those of the three-wire method.

A measurement circuit utilizing a compensation loop is connected to the CL521 similar to the three-wire method.

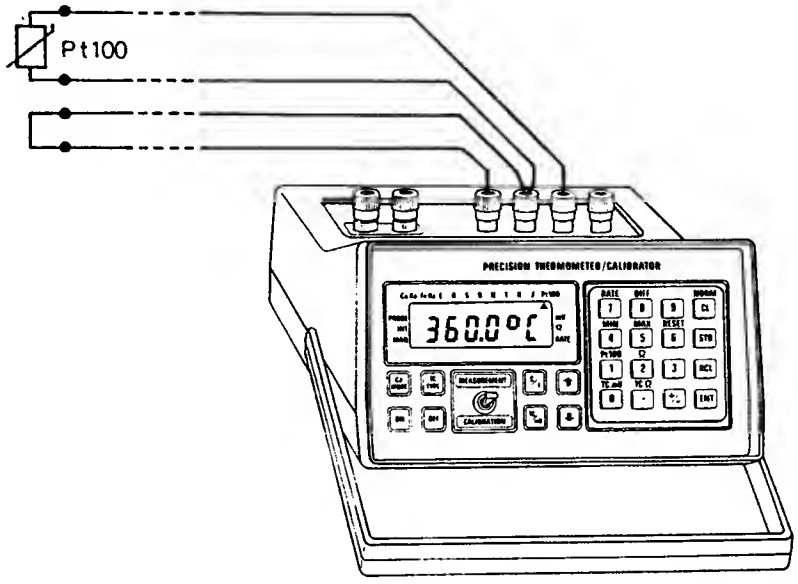


Figure 5-5. Connecting a 2-Wire Resistance Probe with a Lead Compensation Loop to the CL521

5.3 Pt100 TEMPERATURE MEASUREMENT

Connect the probe directly or through a connecting cable to the CL521. No line resistance trimmers are needed. Use four-wire connections if possible.

If the CL521 was most recently used for Pt100 measurements, it is ready to use once the power is switched on. If it was not recently used for Pt100 measurement:

Check that the MEASUREMENT/CALIBRATION switch is in the MEASUREMENT position.

Select Pt100 measurement by pressing the Pt100 key.

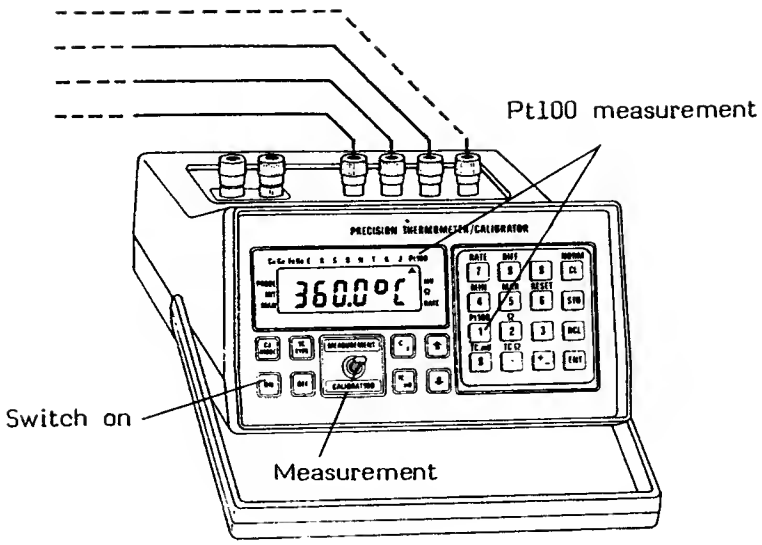


Figure 5-6. Pt100 Temperature Probe Measurement with the CL521

The display will indicate the probe temperature, while an arrow at the top of the display indicates Pt100 measurement mode. The displayed temperature units are those most recently used. To change the temperature units, press the °C/°F key once.

Pt100 temperature measurement works in the range of -200 to 1200°C. If the probe temperature goes below or above this range, the display will blink the minimum or maximum value to indicate range underflow or overflow. If the measurement circuit is broken, the display will indicate "OPEN".

If the temperature reading of the Pt100 sensor is unreasonable or the display indicates "OPEN," the Pt100 sensor is probably broken or incorrectly connected. The TCΩ measurement function can now be used to determine the correct lead assignments. First determine the probe wiring. Then determine three or four wire lead assignments by systematically measuring resistances between the various leads.

The TCΩ function is switched on by pressing the TC&mV key followed by the TCΩ key. Return to the Pt100 measurement mode by pressing the Pt100 key.

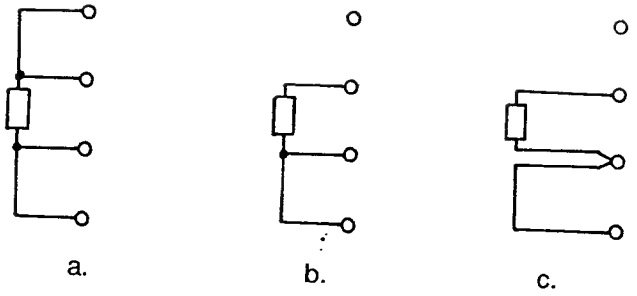


Figure 5-7. Basic methods of ohm and Pt100 measurement connections

a. Four-Wire Connection
b. Three-Wire Connection
c. Two-Wire Connection with Compensation Loop

5.4 RESISTANCE MEASUREMENT

The CL521 can also be used to measure resistances. The resistance measurement mode is selected by pressing the Ω key.

The resistance to be measured is connected like a Pt100 probe using a three or four-wire connection. The arrow at the top of the display indicates Pt100 sensor resistance measurements. The arrow at the right edge of the display indicates basic Ω measurements.

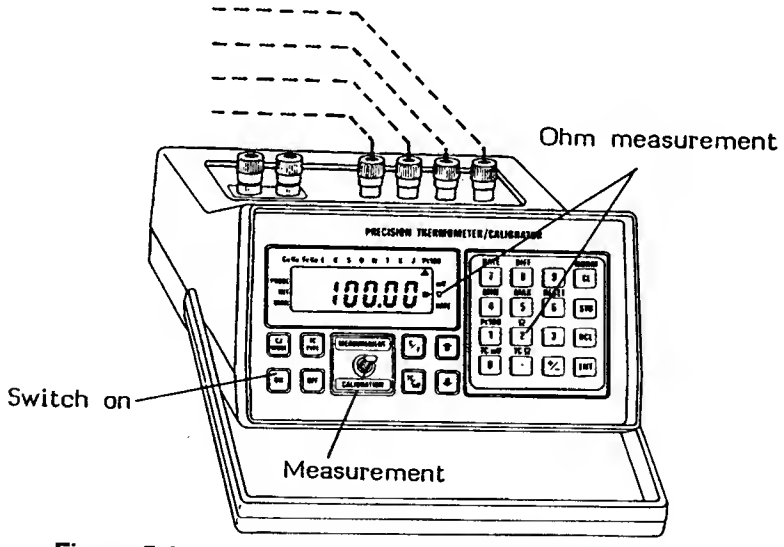


Figure 5-8. Resistance Measurement with the CL521

The resistance measurement range is 0 to 400 ohms. If the measured resistance is above this range, the display will blink the maximum value to indicate range overflow. If the measurement circuit is broken, the display will indicate "OPEN."

Resistance measurements can be used, for example, to determine temperature using resistance probes other than the Pt100. In applications not requiring high accuracy, it is often more convenient to use the two-wire TC Ω measurement mode.

SECTION 6 ADDITIONAL MEASUREMENT FUNCTIONS

6.1 USING OTHER MEASUREMENT FUNCTIONS

The additional measurement functions may be used whenever the MEASUREMENT/ CALIBRATION switch is in the MEASUREMENT position.

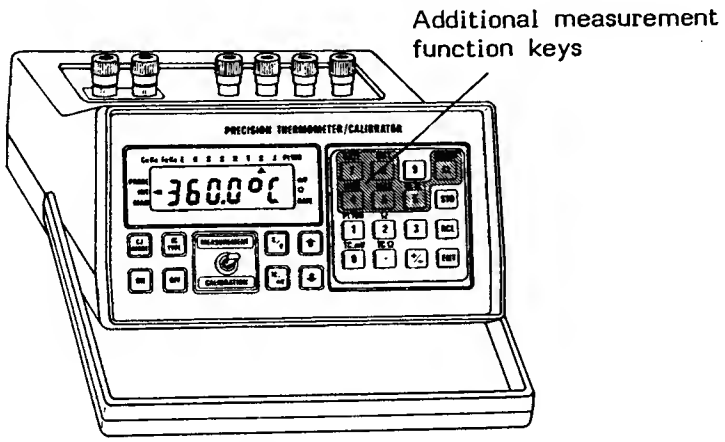


Figure 6-1. Additional Functions with the CL521

To return to the normal measurement mode from another measurement function, press the NORM key.

6.2 MONITORING RATE OF CHANGE

The rate of measurement change is normally calculated from the change occurring during a period of 12 seconds. If the change is very small, however, the period is automatically stretched up to two minutes to get better resolution. The change in rate display is obtained by pressing the RATE key. The function is indicated by the letter "r" at the left side of the display.

The value is shown in °C/min, °F/min, mV/min, or ohm/min. This function is intended for use mainly to facilitate monitoring of temperature stabilization in a calibration oven.

6.3 MEASUREMENT OF DEVIATION

Pressing the DIFF key causes the deviation from the value stored in Register 8 to be shown on the display. This function is indicated by the letter "d" at the left side of the display. Deviation measurements can be used, for example, to investigate the behavior of temperature controllers (thermostats).

The deviation function comparison value is zeroed whenever the CL521 is switched on. To check or set this value, proceed as follows.

Set the MEASUREMENT/CALIBRATION switch to the CALIBRATION position.

To recall the comparison value (contents of Register 8), enter:

RCL 8

To set a new comparison value, for example 20.0, enter:

20.0 STO 8

After checking and/or setting the comparison value, remember to return the MEASUREMENT/CALIBRATION switch back to the MEASUREMENT position.

6.4 CHECKING MINIMUM AND MAXIMUM READINGS

The CL521 stores the minimum and maximum values shown on the display, starting from the time it is switched on. The minimum and maximum values can be recalled by pressing the MIN or MAX keys, respectively. The MIN and MAX functions are indicated by the letters "L" (low) and "H" (high) at the left edge of the display. The values are reset to the current display value when the RESET key is pressed or a new main function is selected.

6.5 RETURNING TO NORMAL MEASUREMENT MODE

To return to the normal measurement mode from another measurement function, press the NORM key.

SECTION 7 THERMOCOUPLE SIMULATION AND MILLIVOLT CALIBRATION

7.1 PRINCIPLE OF THERMOCOUPLE SIMULATION

Thermocouple simulation refers to the process of replacing a thermocouple with a device which mimics the functioning of the thermocouple. The simulator is given a temperature value, which it then converts into a corresponding potential. To the measuring device, the simulator appears as a thermocouple at the set temperature. Thermocouple simulation can be used to check temperature indication devices, plotters, transmitters, and other equipment related to a thermocouple probe.

If thermocouple extension cable is used in the measuring circuit, an extra thermovoltage will be created at the point where the simulator is connected to the extension cable. The simulator must be able to compensate for this extra potential.

7.2 THERMOCOUPLE SIMULATION

7.2.1 Connection and Selection Compensation Modes

All reference junction compensation modes of the CL521 can be used in thermocouple simulation. Compensation is needed for thermopotentials arising from simulator connection into the measuring circuit. The choices are:

A) Internal reference junction compensation, CJ MODE = INT

B) Reference junction compensation using a Pt100 probe, CJ MODE = PROBE

C) Manual reference junction compensation, CJ MODE = MAN

A) INTERNAL REFERENCE JUNCTION COMPENSATION, CJ MODE = INT

The CL521 replaces the thermocouple in the measurement circuit and is connected with thermocouple wire or thermocouple extension wire. The thermoelectric potential created by the connections at the simulator binding posts is automatically eliminated with the aid of the internal temperature sensor. This is a simple method to account for reference junction temperature. Remember to use the correct type and polarity of extension wires.

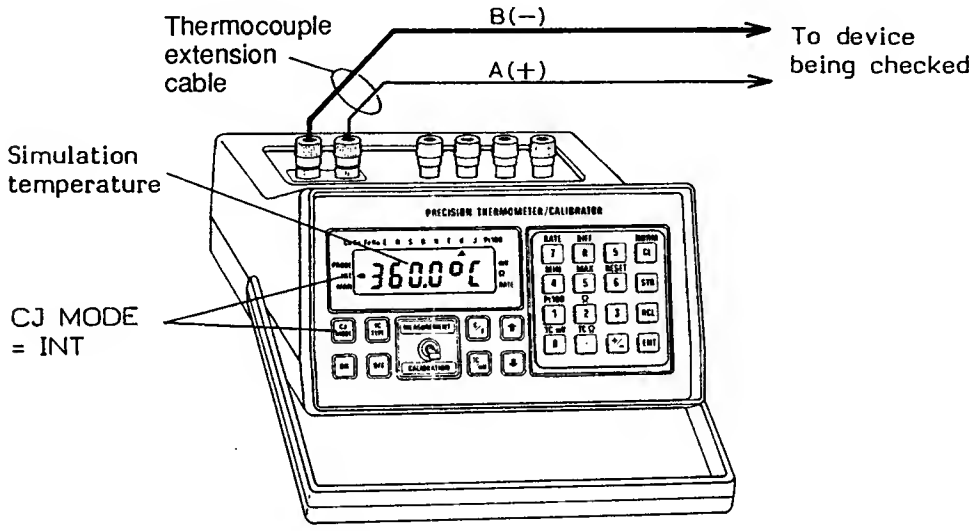


Figure 7-1. Internal Reference Junction Compensation with the CL521

B) REFERENCE JUNCTION COMPENSATION USING A Pt100 PROBE
CJ MODE = PROBE

The CL521 is connected to the measuring circuit with copper wires. An extra thermoelectric potential occurs at the point where the copper conductors are attached to the thermocouple extension wire. The temperature at this point is measured with a Pt100 probe connected to the CL521. When using this method, no problems arise from connection wire type and polarity. It is, however, necessary to place the Pt100 probe at the connections so that it will be at the same temperature as the connections for which the compensation is necessary.

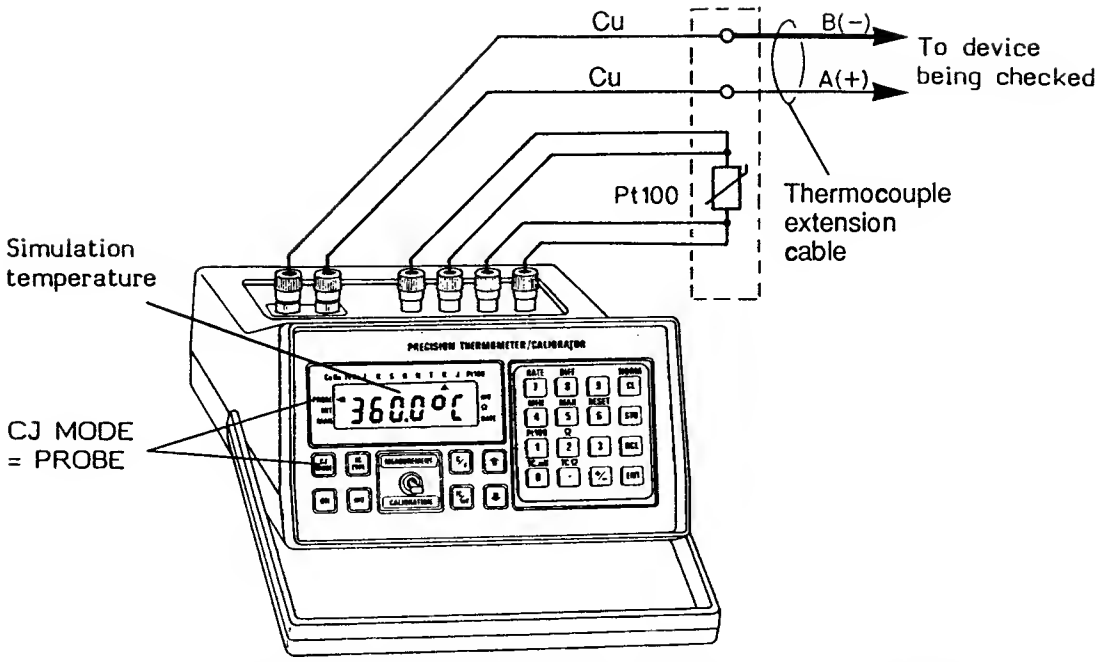


Figure 7-2. Reference Junction Compensation Using a Pt100 Probe to Measure the Reference Junction

C) MANUAL REFERENCE JUNCTION COMPENSATION, CJ MODE = MAN

The manual mode is used if the device being checked does not have reference junction compensation, or compensation has been disconnected. The CL521 is connected directly to the device with copper conductors. Compensation is not necessary, since no thermoelectric potentials are present in the circuit. This method eliminates errors resulting from reference junction compensation, and thus the functioning of the device itself is tested. In this case, the operation of the reference junction compensator must be tested separately.

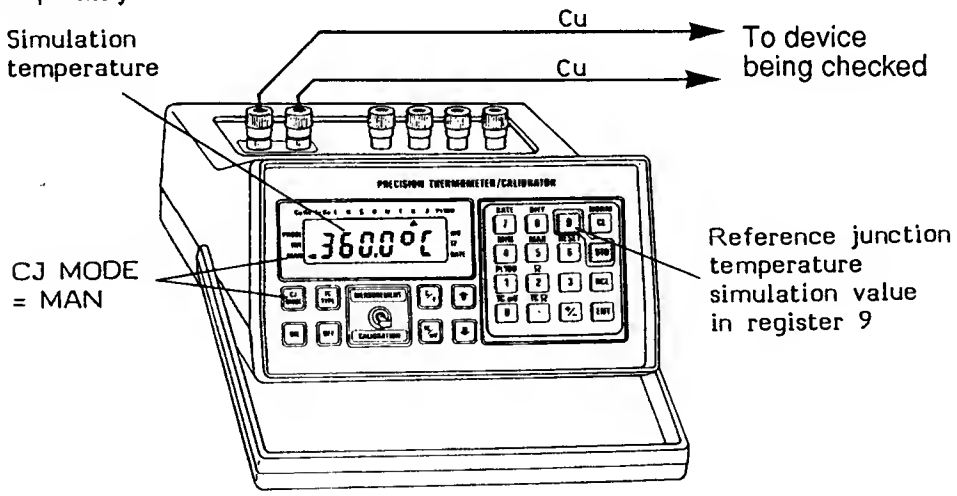


Figure 7-3. Manual Reference Junction Compensation with the CL521

If the measuring device is intended for use so that the reference junction temperature is controlled at some temperature other than 0°C, this temperature must be entered into Register 9 in °C. For example, to enter 50°C into Register 9, enter:

5 0 STO 9

7.2.2 Simulation

Turn on the CL521 by pressing the ON key. If the CL521 was most recently used to perform a similar simulation, it is ready to use once the power is switched on. If it has not recently been used for simulation:

Check that the MEASUREMENT/CALIBRATION switch is in the CALIBRATION position. If thermocouple measurement is selected, the display indicates a value of 0.

If the arrow at the top of the display indicates Pt100, press the ENT key. The CL521 changes automatically to thermocouple measurement and displays a value of 0.

If the displayed value is in millivolts (the arrow at the right edge of the display points to mV), change the units to temperature by pressing the TC/mV key once.

Select the required thermocouple type by repeatedly pressing the TC TYPE key until the arrow at the top of the display indicates the requested type.

Select the required reference junction compensation mode by repeatedly pressing the CJ MODE key until the arrow at the left edge of the display indicates the required mode.

If the Open Input Check used in the instrument being checked disturbs the CL521 operation, it must be switched off during the time of simulation.

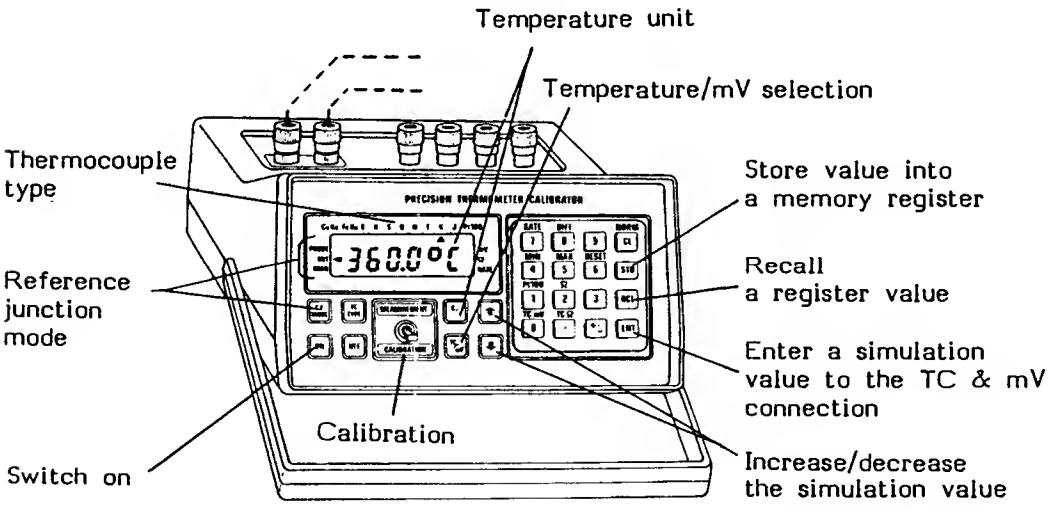


Figure 7-4. CL521 Calibrator/Thermometer

The CL521 now operates as a thermocouple simulator, continuously maintaining an output potential at the thermocouple terminals which corresponds to the value shown on its display. If, for example, the potential changes due to a change in load, the display is cleared until the CL521 has corrected the potential to the correct value. The temperature units shown are the ones most recently used. To change the temperature units, press the °C/°F key once.

The CL521 has the ability to simulate ten commonly used thermocouple types. To simulate some other thermocouple type, millivolt calibration must be used and millivolt values must be obtained by utilizing a temperature-to-millivolt conversion table.

There are many methods of entering new calibration values:

- Entering new values with the numeric pad:

To enter, for example, 25°C, enter:

2 5 ENT

- Recalling values from memory Registers 0 to 6:

Frequently used calibration values can be stored into memory Registers 0 to 6. The register values are kept in memory even if the CL521 is switched off. For example, to store the value 625.3 into Register 3, enter:

6 2 5 . 3 STO 3

To use the contents of memory Register 3 as a calibration value, enter:

RCL 3 ENT

- Stepping through preset values:

Memory Registers 0 to 4 can be used to hold convenient test values, such as 0%, 25%, 50%, 75%, and 100% of full scale. The CL521 can be set to step through these simulation values. Automatic stepping is started by entering:

RCL ENT

and is stopped by pressing the CL key or any numeric key.

The duration of each simulation value in automatic stepping is preset to 12 seconds. If necessary, the duration can be changed by storing a new duration time in the range of 5 to 1000 (seconds) into Register 7. For example, to set the duration to 60 seconds, enter:

6 0 STO 7

- Increasing or decreasing the output signal smoothly:

If the measuring device must be made to show some specific steady reading, first enter the corresponding calibration value from the numeric pad, and then change it using the Up and Down arrow keys until the measuring device shows the required reading. If the necessary correction is large, press the arrow key for a longer time. After one second, the calibration value will begin to change at a progressive rate. Release the key before the measuring device indication approaches the required value and continue with single steps if necessary.

Each thermocouple type has been assigned a specific simulation range. If values outside this range are used, the display will flash the corresponding maximum or minimum value. If the compensation temperature goes outside the range of -10 to +70°C, the display will indicate "CJ LO" or CJ HI" correspondingly.

7.2.3 The Effect of Loading

The CL521 thermocouple output is restricted to about 0.6 mA (E = 60 mV). Thus the stabilization time of the simulation value increases when devices that cause circuit loading, such as wirewound meter movement devices, are being checked. If the device contains a short circuit, or if the resistance of the device to be checked is too low, "OLOAd" is displayed. If reaching the simulation value takes more than about two seconds, the resistance of the measuring device is so small that the effect of the lead resistance must also be considered.

Wirewound meter movement devices used in conjunction with thermocouples are normally calibrated for proper indication when the total lead resistance of the conductors is known, commonly ten or twenty ohms. The necessary conductor lead resistance is marked on the indicating device. When checking such devices, an equivalent resistance must be included in the circuit.

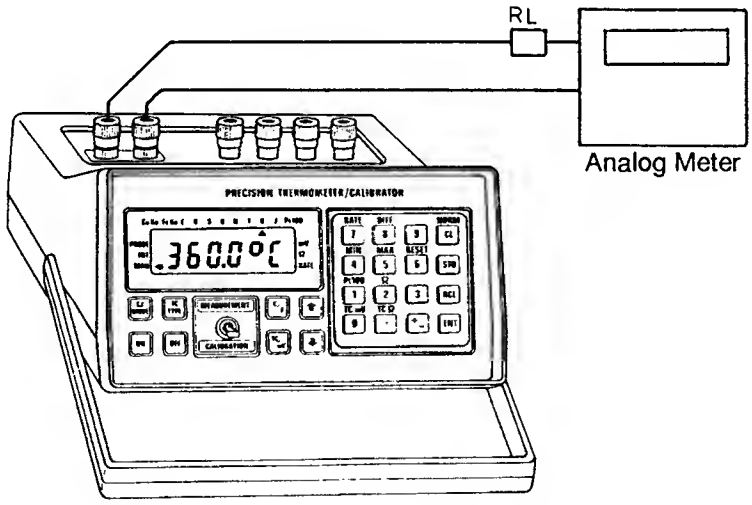


Figure 7-5. Calibrating an Analog Meter with the CL521

When part of the original wiring is included in the circuit that is being checked, the added resistor must be adjustable. The wire resistance should be set to the required value by shorting the indicating device and using the TC Ω measurement on the CL521.

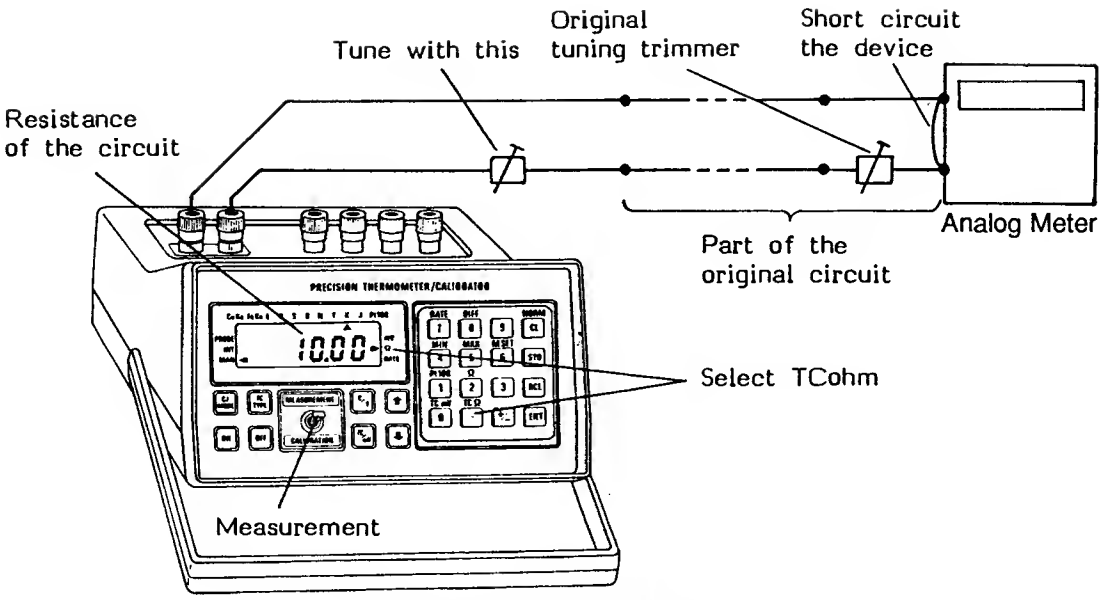


Figure 7-6. Calibrating an Analog Meter with the CL521

NOTE: The indicating device may be damaged if its connections are not shorted during measurement!

7.3 MILLIVOLT CALIBRATION

In thermometer calibration, the user enters the required temperature values, and the CL521 provides the corresponding millivoltage to the TC and mV terminals. Millivolt values can also be entered directly as millivolts for output at the terminals. The available range from the CL521 is -10 to +110 mV.

To switch from thermocouple calibration to millivolt calibration, or vice-versa, simply press the TC/mV key once.

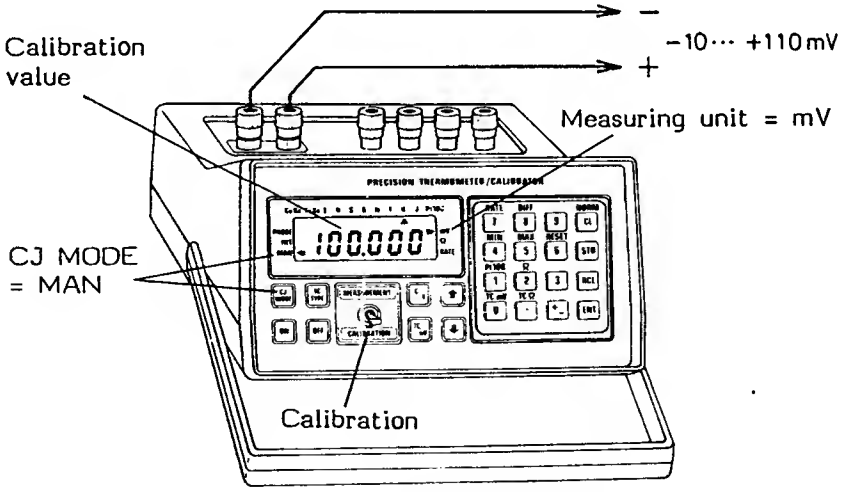


Figure 7-7. Millivolt Calibration Using the CL521

As in thermocouple calibration, loading of the calibration signal is indicated by an increase in the signal stabilization time. At 110 mV, the CL521 can supply a current of about 0.3 mA.

SECTION 8 RS-232C OPTION

8.1 GENERAL DESCRIPTION

The RS-232C Option includes Digital input/output and Analog output.

Digital input/output:
- Serial I/O compatible with RS-232 C
- For remote control by computer, or interfacing to a printer
- Selectable transmission rate 150/600 baud
- Isolated from the measurement

Analog output:
- Voltage proportional to the display reading in measurement mode
- During normal operation, 1 mV of analog output voltage corresponds to 1 degree, 0.1 mV, or 0.1 ohm of the display reading.
- Output voltage is multiplied by 10 when deviation measurement is selected.
- Output is isolated from the measurement circuits
- Accuracy: 0.2% rdg ±1 degree, 0.1 mV or 0.1 ohm in normal measurement (0.2% rdg ±0.1 degree, 0.01 mV or 0.01 ohm in deviation measurement)

8.2 INSTALLING THE RS-232C DIGITAL INTERFACE OPTION

If you are field installing your option, follow this procedure. Before installing the option, disconnect the AC Power Adaptor and switch the CL521 off by pressing the OFF key. Next remove the four screws at the bottom of the unit and carefully lift the rear of the upper cover and remove the cover.

Remove the dummy plate at the rear of the unit and replace it with the option. Connect the option to connector J3 on the main board as shown in Figure 8-1. Make sure that the front end of the card fits into the guiding slot. Before screwing the option to the rear panel of the CL521, check the position of the baud rate switch (see Section 8.2.1).

After replacing the upper cover of the CL521, the option is ready for use.

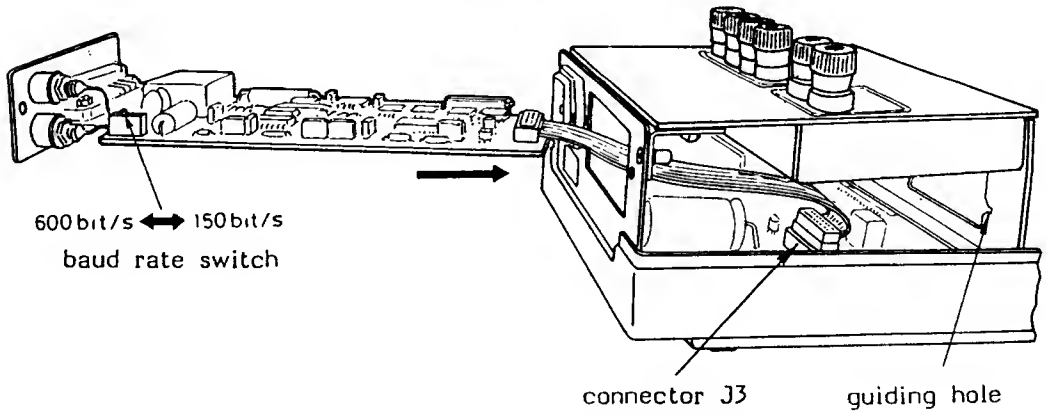


Figure 8-1. Installing RS-232C Option

8.2.1 Data Format and Baud Rate

The digital interface puts out measurement results to a printer or enables the CL521 to be remotely controlled by a computer. The interface is isolated from the measurement circuits of the CL521 by means of optocouplers and a DC/DC converter.

The digital interface is a serial interface conforming to the RS-232C standard. The standard was originally intended to be used in interfaces between data terminal equipment (DTE) and data communication equipment (DCE), but it is also widely used in interfaces between microcomputers and peripheral devices like printers. The characters are binary coded and transferred in serial form using only one line. The beginning of the transfer of each character is indicated by one start bit of logic zero (positive voltage). The eight data bits of characters are transferred beginning from the least significant bit. At least one stop bit of logical one (negative voltage) is needed to separate the characters from each other. The CL521 is wired as a RS-232C standard DTE type device. The characters transmitted are coded according to the 7-bit ASCII code. The bit b7 just before the stop bit is always set to zero. When receiving characters from the computer, the CL521 does not care about the state of the bit b7.

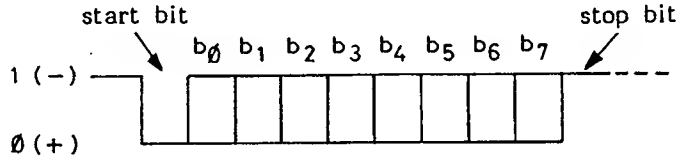


Figure 8-2. Serial Data Format

The data format of the computer or the printer must be set to conform to the data format of the CL521. The proper settings are: no parity bit, one stop bit, eight data bits.

In some devices, the number of data bits is always seven and the eighth bit is used as a parity bit. Those devices must be set so that no parity check is done for the received data.

In addition to the common data format of the connected devices, they also must use the same data transmission rate. The rate is measured in units of bits/s (baud). The baud rates used in the CL521 are 150 bits/s or 600 bits/s. The rate is selected with a switch on the option card (see Figure 8-1). If the baud rate switch position is changed after the CL521 is switched on, the new rate setting is not recognized until the CL521 is switched OFF and ON again.

8.2.2 Connection Cables

Connection cables for a computer or a printer are not supplied with the CL521 due to microcomputer manufacturers using different pin configurations, or even different connector types, on their computers.

Output to the serial interface of the CL521 can be stopped by connecting Pin 5 of the connector to a negative voltage. During normal operation, Pin 5 must be kept positive. This can be easily done by connecting it to Pins 4 or 20 (Pins 4 and 20 are internally connected to a positive voltage).

Printers are normally wired as RS-232C DTE devices, and computers as DCE devices. Suitable cables for standard computers and printers are illustrated in Figures 8-3 and 8-4 (wires drawn with dotted lines may not be needed in all devices). Some microcomputers are wired as DTE devices. The cable of Figure 8-4, with one additional wire from the computer connector Pin 2 to the CL521 connector Pin 3, can normally be used in those cases. Check the instruction manual of your printer or computer to find the suitable cable connection.

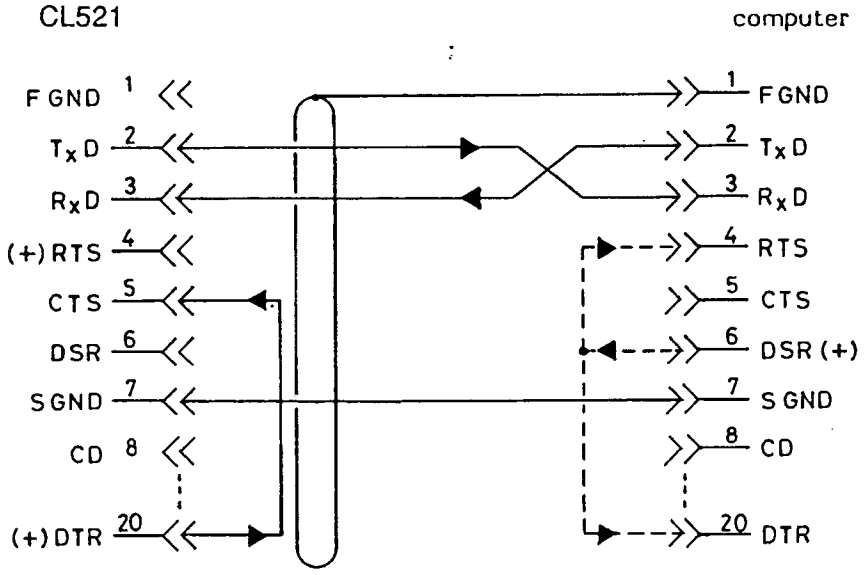


Figure 8-3. Connection Cable for a Computer

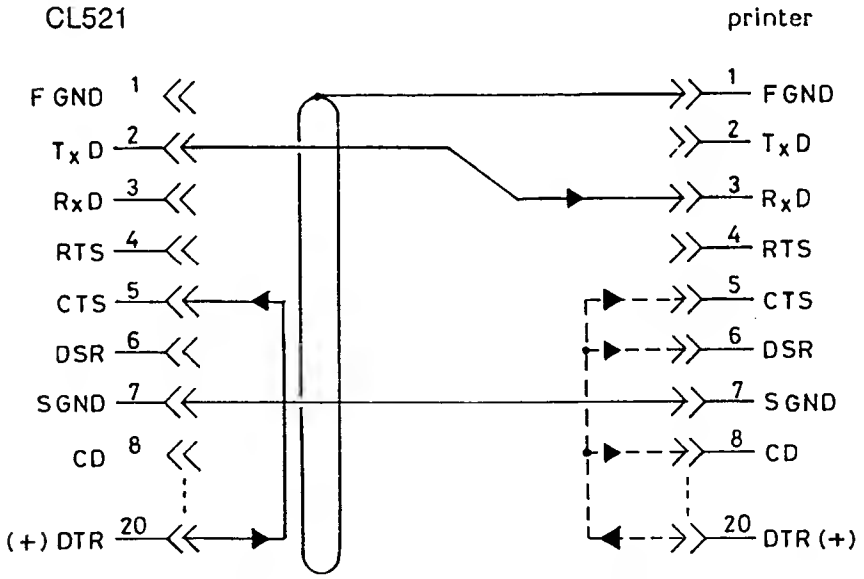


Figure 8-4. Connection Cable for a Printer

8.2.3 Output Message Format and Timing

After switching the CL521 on, it starts to send messages to the digital output. The length of a message is 18 characters and the time interval between two messages is initially set to 12 seconds. When needed, the time interval may be changed by storing the new time interval in seconds in memory Register 7 (Register 7 also controls the timing of the calibration value step function). Any value from 5 to 1000 seconds can be stored.

To set the time interval of one minute (60 seconds):

Set the MEASUREMENT/CALIBRATION switch to the CALIBRATION position.

Key in: **6 0 STO 7**

The output message string consists of the following parts:

Char 1 Main function:	M = Measurement C = Calibration
Chars 3, 4 Sensor type:	E = Chromega™ -Const R = Pt13%Rh-Pt S = Pt10%Rh-Pt B = Pt30%Rh-Pt6%Rh N = Nicrosil-Nisil T = Cu-CuNi (ASTM) K = Chromega™ -Alomega™ (NiCr-NiAl) J = Fe-CuNi (ASTM) TD = Cu-CuNi (DIN) JD = Fe-CuNi (DIN) P = Pt100
Chars 6 - 8 Special function:	MIN = Minimum reading MAX = Maximum reading RAT = Rate of change of the measurement TCR = Thermocouple resistance measurement DIF = Deviation measurement
Chars 10 - 17 Reading:	The first character of the reading is + or -; the digits follow after the sign. The format of the reading is the same as in the display.
Char 18 Meas. unit:	C = °C F = °F R = ohm space = mV

Print-out examples:

```
M P  RAT  +1000.0  C
C JD           -0.1  C
M K          +666.6  F
M P  MIN     -15.00  C
M J          -9.990
```

8.2.4 End Characters of the Output Message

After sending the message string, the CL521 always sends two end characters. In start-up, the end characters are set to CR and NUL (0DH and 00H). CR (Carriage Return) returns the printer carriage and in many printers, it also feeds the paper one line (auto-line feed). The printers normally neglect the NUL code. If the printer cannot be set to the auto line feed mode, a LF (Line Feed) code (0AH) is needed to feed the paper. The end characters may be changed by connecting a computer to the digital interface and entering the command "Y1F0" or "Y2F0" (see Section 8.2.5). The new end characters set by the computer are used until the CL521 is switched off.

8.2.5 Remote Control by Computer

The operation of the CL521 can be controlled by a computer connected to the digital interface. After a command from the computer is received, all further keypad operations are neglected until the F0 command from the computer is received. The usable computer commands are listed below:

A. Function selection:

- F0 Allows front panel operations
- F1 Selects thermocouple measurement/calibration mode
- F2 Selects resistance measurement
- F3 Selects Pt100 measurement
- F4 Selects thermocouple resistance measurement (thermocouple measurement must be selected before the F4 command)

B. Special function selection:

- S0 Returns to normal operation
- S1 Displays the minimum reading
- S2 Displays the maximum reading
- S3 Deviation measurement
- S4 Displays the rate of measurement change
- S5 Displays the reference junction temperature

C. Thermocouple type selection:

- T0 Type E Chromega™ -Const
- T1 Type R Pt13%Rh-Pt
- T2 Type S Pt10%Rh-Pt
- T3 Type B Pt30%Rh-Pt6%Rh
- T4 Type N Nicrosil-Nisil
- T5 Type T Cu-CuNi (ASTM)
- T6 Type K Chromega-Alomega (NiCr-NiAl)
- T7 Type J Fe-CuNi (ASTM)
- T8 Type TD Cu-CuNi (DIN)
- T9 Type JD Fe-CuNi (DIN)

D. Entering Calibration Values

V + reading

The first character of the value may be a digit, +, - or a space.
Only the first five digits of the reading are recognized.

V command examples:
V100.00
V 100.00
V+100.00
V-5
V1234.5

E. Triggering the Digital Output

After the CL521 is switched ON, it starts to put out messages at the digital output. The time interval between messages is determined by memory Register 7. The automatic output is meant to be used with a printer.

P1 Disables the automatic output and requests one output message. The requested output message is sent after this command.

P0 Re-enables the automatic output. The first output message is sent just after this command and the following messages with the time interval determined by the memory in Register 7.

F. Setting the End Characters of the Digital Output

After the CL521 is switched ON, all output messages are followed by the codes CR (0DH) and NUL (00H). If the printer cannot feed the paper with this end character combination, the end characters can be changed with computer command Y. The new end characters set by the computer are used until the CL521 is switched OFF.

Depending on the method the computer uses in reading the messages of the CL521, the change of the end character combination may also provide changes to the computer programs.

Y0 End characters of a message are CR (0DH) and NUL (00H)
Y1 End characters of a message are CR (0DH) and LF (0AH)
Y2 End characters of a message are LF (0AH) and CR (0DH)

The computer program for the CL521 control is easy to write using BASIC language. The details of the program depend on it's purpose, the BASIC used, and the computer. The example program is for an Epson HX-20 microcomputer. The language conforms to the widely used Microsoft BASIC, except in reading the time and opening the serial communications channels.

```
10 OPEN "O,"#2,"COM0:(38N1F)"
```

Opens the RS-232 output as File No. 2. The baud rate is set to 600 bits/s (3), the data format is eight data bits (8), no parity bit (N) and one stop bit (1). No hand shaking is used in the data transfer (F).

```
20 PRINT#2,"P1"
```

P1 causes output of one message and disables the automatic output. If the CL521 is just putting out the latest automatic message, it may disturb the program operation, therefore, it is best to neglect the first requested message with a proper delay before opening the RS-232 input.

```
30 FOR T=0 TO 1000:NEXT
```

The delay.

```
40 OPEN"I",#1,"COM0:(38N1F)"
```

Opens the RS-232 input as File No. 1.

```
50 PRINT#2,"F1T6P1F0"
```

Thermocouple measurement with TC type K is selected and one output message requested. Keypad operations are allowed.

```
60 INPUT#1,L$
```

Receives an input message.

```
70 IF LEFT$(L$,1)<>"M" THEN
    PRINT"Turn the M/C switch":
    PRINT"to MEASUREMENT":
    PRINT"and press RETURN":
    CLS:INPUT A$:GOTO 50
```

Check of M/C switch position

```
80 IF RIGHT$(L$,1)<>"C" THEN
    PRINT"Select Celsius":
    PRINT"as the meas. unit":
    PRINT"and press RETURN":
    CLS:INPUT A$:"GOTO 50
```

Check of measuring unit

```
90 CLS:PRINT"Check the
    wiring":PRINT
    "and CJ mode":
    PRINT"and press RETURN":
    INPUT A$:CLS
```

Check of connections

```
100 PRINT"TRACKING OF":PRINT
   "TEMPERATURE":PRINT"CHANGES"
```

Program heading

```
110 START=1                          Make sure that the initial reading
                                     is printed.

120 PRINT#2,"P1F0"                   Request and receipt of an

130 INPUT#1,L$                       input message from the CL521

140 T=VAL(MID$(L$,10,8))             Separation of the reading

150 IF (ABS(T-XT)=>0.5)              If the temperature is changed 1/2 degree
    OR (START=1) THEN                or more, the time and the temperature
    LPRINT TIME$;:LPRINT             are printed
    USING"#####.# C";T

160 START=0:XT=:GOTO 120             Next measurement
```

The output of the example program could be the following:

```
09:28:12    124.3 C
09:28:45    124.8 C
09:29:03    125.2 C
```

The computer commands to the CL521 may be series connected in strings as written in the example program. The maximum length of a command string is 20 characters. The execution of the commands is started only after the entire string is received. The CL521 notices the end of the string after receiving a CR code (the CR code is automatically sent after the string when using the PRINT# statement without a semicolon at the end).

If several commands are sent using separate PRINT# statements, a proper delay is needed between the commands to give the CL521 time to execute the earlier commands.

No other commands can be series connected to the same command string after a V command.

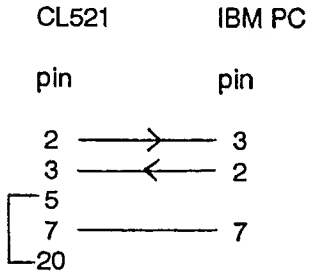
The special function commands S1 to S5 can be used when the CL521 is in the MEASUREMENT mode. Return to normal measurement is done with the S0 command. For example, a reference junction temperature message is requested with the command string S5P1S0. However, the command S5 can also be used in the CALIBRATION mode. In the CALIBRATION mode, the reference junction temperature message is requested with the command string S5P1, and the reading is displayed until the next V command is received.

Instead of the upper case command characters, the respective lower case characters can also be used.

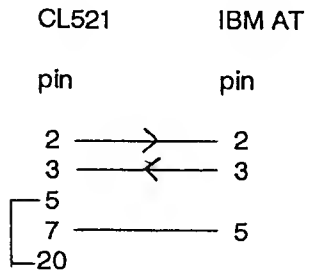
```
'    ************************************************************************
'    This example program communicates with the CL521. It is made for an IBM PC
'    compatible microcomputer. The language is Microsoft GW-BASIC.
'    ************************************************************************

'    Open the RS232 line for both input and output as a file No. 1. The baud rate is set to
'    600 bit/s, no parity bit (N), the data format is eight data bits (8), and one stop bit (1).
'    the device timeout is not checked (CS0, DS0, CD0)
10   OPEN "COM1: 600,N,8,1,CS0,DS0,CD0,BIN" FOR RANDOM AS #1

'    Fills input buffer with spaces
15   L$ = SPACE$(20)

'    Send "P1" message to the CL521. P1 causes output of one message and disables
'    the automatic output. The input line should be cleared before continuing the
'    program execution. If there is extra characters on the line, it would disturb the
'    program execution later.
20   PRINT #1, "P1"
25   WHILE LOC(1) > 0
28   L$ = INPUT$(1, #1)
30   WEND

'    The thermocouple measurement with TC-type K is selected and one output
'    message requested. The keypad operations are allowed.
40   PRINT #1, "F1T6P1F0"

'    Wait until the entire message is on the line
45   WHILE LOC(1) < 20
48   WEND

'    Read the message from the line
50   L$ = INPUT$(20, #1)

'    Check of M/C-switch position.
60   IF LEFT$(L$, 1) = "M" THEN 90
70   INPUT "Turn the M/C-switch to MEASUREMENT and press RETURN"; A$
80   CLS : GOTO 40


'    Check of meas. unit.
90   IF MID$(L$, 18, 1) = "C" THEN 120
100  INPUT "Select Celsius as the meas. unit and press RETURN"; A$:
110  CLS : GOTO 40

'    Check of connections.
120  CLS : INPUT "Check the wiring and CJ-mode and press RETURN"; A$: CLS

'    Program heading on the screen
130  PRINT "TRACKING OF TEMPERATURE CHANGES"
```

```
'     Make sure that the initial reading is printed.
140 START = 1: XT = 0

'     Request and receive of an input message from the CL521.
150 PRINT #1, "P1F0"
155 WHILE LOC(1) < 20
158 WEND
160 L$ = INPUT$(20, #1)

'     Get the measure value from the reading.
170 T = VAL(MID$(L$, 10, 8))

'     if the temperature is changed 1/2 degrees or more, the time and the temperature is
'     printed.
180 IF ABS(T - XT) < .5 AND START = 0 THEN GOTO 150
190  LPRINT TIME$; USING "#####.# C"; T
200  XT = T: START = 0

'     Next measurement
210 GOTO 150
```

The RS232 cable connection between the CL521 and 25 pins IBM PC computer:



The RS232 cable connection between CL521 and 9 pins IBM AT computer:



8.3 ANALOG OUTPUT

The analog output is intended to be used for connecting a recorder. The output is isolated from the measurement circuits by means of optocouplers and a DC/DC converter. The electronics needed for the output is placed on the same board as the CL521-RS232C Option.

The output voltage is 1 mV/1 degree of the reading and 10 mV/1 ohm or 1 mV of the reading.

When measuring the deviation from the preset value (DIFF function), the normal output voltage is multiplied by 10. The output voltage is limited to the range -595 to +3500 mV.

8.3.1 Analog Output Specifications

Normal measurement:

Display reading	Output voltage
-255 to 2370°C	-255 to 2370 mV
-418 to 3500°F	-418 to 3500 mV
-10.0 to 110.0 mV	-100 to 1100 mV
0 to 350.0 ohms	0 to 3500 mV

Deviation measurement:

Display reading	Output voltage
-59.5 to 350.0°C	-595 to 3500 mV
-59.5 to 350.0°F	-595 to 3500 mV
-5.95 to 35.00 mV	-595 to 3500 mV
-5.95 to 35.00 ohms	-595 to 3500 mV

SECTION 9 SERVICE AND CALIBRATION

CL521 does not need any regular service except for calibration checks. In case the unit is not functioning properly, we suggest you contact OMEGA, since troubleshooting of microprocessor-based circuits can be very difficult without a thorough knowledge of both the hardware and software of the unit.

We suggest the calibration of the CL521 is checked approximately six months after delivery. The proper calibration period after that is one year.

To check the calibration of the unit, the four screws at the bottom of the unit must be removed. To remove the top cover, the rear of it must first be carefully lifted. When the cover is removed, the calibration can be done easier by removing the screws at the front and back of the terminal panel and lifting the panel aside.

Calibration is performed with the CL521 in battery operation (disconnected from the AC Power Adaptor). Switch the unit on for about ten minutes before performing the calibration procedure.

The following equipment is needed for calibration:

- Voltage standard, voltage 50 to 110 mV, error less than 5 uV
- Resistance standard, resistance 100 to 400 ohms, error less than 20 mohm
- K type thermocouple probe
- Ice bath, or OMEGA TRCIII Ice Point Reference Chamber

Calibration is rather different because of the software involved with the CL521. In some cases, this means that the effect of an adjusting operation will not be seen on the display until after approximately one minute. After turning a trimmer, always wait until you can see the effect on the display.

Connect the voltage standard to TC.mV In/Out terminals and select mV measurement. The reference junction compensation must be switched off (CJ is MAN and 0°C set in Register 9). The display can be corrected to the right reading if necessary, using trimmer R7 on the main board.

Next calibrate the resistance measurement mode. Connect the resistance standard to the Pt100 in terminals of the CL521 and select ohm measurement. If necessary, adjust the trimmer "Pt100 SPAN" at the front of the terminal panel, until the display reading is correct.

The next calibration step is the internal reference junction compensation. Select thermocouple measurement, type K thermocouple and internal reference junction compensation. Connect the type K thermocouple probe and put it into a 0°C ice bath or OMEGA TRCIII. The display should show 0°C. If necessary, adjust the display reading to the correct value using the "CJ ZERO" trimmer at the front of the terminal panel.

If there is a CL521-RS232C Option card installed in the unit, check the calibration of the analog output signal. The calibration can be done with a resistor of approximately 300 ohms connected to the TC.mV In/Out terminals of the CL521.

First, switch the CL521 to measure the voltage across the resistor and check that the reading is 0 mV ±0.01 mV. Adjust the analog output to zero by using the trimmer ZERO on the option card. Use a DVM that reads to four places.

Then, switch the CL521 to TCΩ measurement and check the display reading. The display digit representing tenths of milliohms should be less than four to make sure that there will be no trouble with rounding. Find a proper reading, for example, by connecting extra test leads in series with the resistor. If the resistance reading is, for example, 312.33 ohms, adjust the analog output to 3123 mV by using the trimmer SPAN on the option card.

Repeat the ZERO and SPAN adjustments until both adjustments are within specification.

The CL521 is now recalibrated. Reassemble the unit and install the cover.

SECTION 10 SPECIFICATIONS

DISPLAY:	6-digit LCD, 0.41" (10.4 mm)
OVERRANGE INDICATION:	Display blinks max. reading of selected range
READING RATE:	1.25 to 2.5 readings per second
WARM-UP TIME:	<1 min.
INPUT IMPEDANCE:	>100 Mohm
NMRR:	>60 dB @ 50/60 Hz
CMRR:	>140 dB @ 50/60 Hz with 1 k ohm imbalance
OVERVOLTAGE PROTECTION:	Inputs protected up to 110 Vac RMS or dc
ACCURACY:	0.02% rdg ±6 mV; thermocouple and mV; 0.02% rdg ±0.04 ohms, RTD and Resistance
COLD JUNCTION COMPENSATION ERROR:	0.2°C at 23°C ±0.01°C/°C
TEMPERATURE COEFFICIENT:	0.002%/°C
OPERATING AMBIENT RANGE:	14 to 122°F (-10 to 50°C), 0 to 80% RH non-condensing
STORAGE TEMPERATURE RANGE:	-4 to 140°F (-20 to 60°C)
POWER:	110/220 Vac, 50/60 Hz
POWER CONSUMPTION:	3 VA max.
BATTERY POWER:	NiCad; 90 h between recharging (10 h for CL521D); low battery indication standard
RECHARGE TIME:	12 hours (20 hours if unit is used during recharging)
DIMENSIONS:	4"H x 7.3"W x 9"D (102 x 185 x 229 mm)
WEIGHT:	4 lbs. (1.8 kg)

RANGES, LINEARITY AND RESOLUTION

Sensor Type and Material	Standard	Range (°C)	Linearity error (°C)	Resolution (°C)
J Fe-CuNi (Fe-Const)	IEC 584-1 ASTM E230	-210 to -200 -200 to 1200	0.2 0.1	0.1 0.1
K NiCr-NiAl (Chromega™ - Alomega™)	IEC 584-1 ASTM E230 DIN 43710	-255 to -220 -220 to -140 -140 to 1372	0.2 0.2 0.1	0.5 0.2 0.1
T Cu-CuNi (Cu-Const)	IEC 584-1 ASTM E230	-255 to -230 -230 to -160 -160 to 400	0.1 0.1 0.1	0.5 0.2 0.1
E NiCr-CuNi (Chromega-Const)	IEC 584-1 ASTM E230	-260 to -250 -250 to -220 -220 to 1000	0.1 0.1 0.1	0.5 0.2 0.1
R Pt13%Rh-Pt	IEC 584-1 ASTM E230	- 50 to 250 250 to 1768	0.1 0.1	0.5 0.2
S Pt10%Rh-Pt	IEC 584-1 ASTM E230 DIN 43710	- 50 to 600 600 to 1760	0.1 0.1	0.5 0.2
B Pt30%Rh-Pt6%Rh	IEC 584-1 ASTM E230	400 to 1200 1200 to 1820	0.1 0.1	0.5 0.2
N Nicrosil-Nisil	NBS Mono-graph 161	0 to 1300	0.1	0.1
Fe-CuNi DIN (Fe-Const)	DIN 43710	-200 to 900	0.2	0.1
Cu-CuNi DIN (Cu-Const)	DIN 43710	-200 to 600	0.2	0.1
Pt100	DIN 43760*	-200 to 200 200 to 1200	0.05 0.05	0.05 0.1

	Range	Resolution
mV	-10 to 110 mV	0.002 mV
ohm	0 to 400 ohms	0.01 ohm

*Pt100 range 850°C to 1200°C is extrapolated from DIN 43760 curve.

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